Claims

1. A method of manufacturing a plastic optical transmission medium with a radially varying refractive index, comprising:

preparing a polymeric tube having at least two concentric cylinders of polymeric material, wherein at least one of said at least two concentric cylinders of polymeric material comprises a diffusible additive which modifies the refractive index of said at least one of said at least two concentric cylinders of polymeric material;

surrounding said polymeric tube with an outer tubing, wherein said outer tubing has a higher glass transition temperature than any of said at least two concentric cylinders of polymeric material;

heating said polymeric tube surrounded by the outer tubing to a temperature which is below the glass transition temperature of the outer tubing and above all of the glass transition temperatures of said at least two concentric cylinders of polymer material, wherein such heating causes diffusion of the diffusible additive in said at least one of said at least two concentric cylinders of polymeric material, wherein such diffusion of the diffusible additive modifies the radial refractive index of said polymeric tube.

2. The method according to claim 1, wherein the diffusible additive is nonpolymerizing.

3. The method according to claim 1, wherein said polymeric tube comprises an inner cylinder of polymeric material and an outer cylinder of polymeric material, wherein said inner and outer cylinders are concentric.

4. The method according to claim 3, wherein said inner cylinder of polymeric material comprises a diffusible additive which raises the index of refraction of said inner cylinder of polymeric material.

5. The method according to claim 3, wherein said outer cylinder of polymeric material comprises a diffusible additive which lowers the index of refraction of said outer cylinder of polymeric material.

6. The method according to claim 3, wherein said polymeric tube comprises a middle cylinder of polymeric material which is between, and concentric with, said inner cylinder of polymeric material and said outer cylinder of polymeric material.

7. The method according to claim 6, wherein said inner cylinder of polymeric material comprises a first diffusible additive which raises the index of refraction of said inner cylinder of polymeric material and said outer cylinder of polymeric material comprises a second diffusible additive which lowers the index of refraction of said outer cylinder of polymeric material.

8. The method according to claim 7, wherein said method produces a polymeric tube having an approximately parabolic radial index of refraction profile.

9. The method according to claim 1, wherein preparing a polymeric tube having at least two concentric cylinders of polymeric material comprises

preparing a corresponding at least two polymeric materials under pressure, wherein at least one of said at least two polymeric materials comprises a diffusible additive which modifies the refractive index of said at least one of said corresponding at least two polymeric materials;

injecting said corresponding at least two polymeric materials into an extrusion die, wherein said polymeric tube having at least two concentric cylinders of polymeric material is extruded from said die.

10. The method according to claim 9, wherein heating said polymeric table surrounded by the outer tubing comprises winding the extruded polymeric tube onto a drum, wherein the drum is located within a heated enclosure.

11. The method according to claim 1, wherein said at least two concentric cylinders of polymeric material comprise the same kind of polymer.

12. The method according to claim 1, wherein at least two of the at least two concentric cylinders of polymeric material comprise different kinds of polymers.

13. The method according to claim 12, wherein the two different kinds of polymers have refractive indices n_1 and n_2 such that $n_1 > n_2$, wherein two non-polymerizing additives with refractive indices n_1^1 and n_2^1 such that $n_1^1 > n_1$ and $n_2^1 < n_2$ are added with the two different kinds of polymers, respectively, and wherein the plastic optical transmission medium has a refractive index profile which is substantially parabolic.

14. The method according to Claim 12, wherein the two different kinds of polymers have refractive indices n_1 and n_2 such that $n_1 \geq n_2$, wherein a non-polymerizing additive with the refractive index n_2^1 such that $n_2^1 < n_1$ is added with the polymer having refractive index n_2, and wherein the plastic optical transmission medium has a refractive index profile which varies only over a short distance around the interface between the two polymers.

15. The method according to Claim 12, wherein the two different kinds of polymers have refractive indices n_1 and n_2 such that $n_1 \geq n_2$, wherein a non-polymerizing additive with the refractive index n_1^1 such that $n_1^1 > n_1$ is added with the first polymer having refractive index n_1, and wherein the plastic optical transmission medium has a refractive index profile which varies only over a short distance around the interface between the polymers.

16. The method according to Claim 1, wherein the polymeric tube comprises three concentric cylinders of polymeric material comprising a first, second, and third polymer, respectively, with refractive indices n_1, n_2, and n_3 such that $n_1 > n_2 > n_3$, wherein the

first and third polymers have added non-polymerizing additives with refractive indices n_1^1 and n_3^1 such that $n_1^1 > n_1$ and $n_3^1 < n_3$, wherein the plastic optical transmission medium has a refractive index profile which is substantially parabolic.

17. The method according to claim 1, wherein the polymeric materials are melt-processable, amorphous materials.

18. The method according to claim 1, wherein the polymeric materials comprise a material selected from the group consisting of: polymethylmethacrylate, polyphenylmethacrylate, polytrifluoroethylmethacrylate, polycarbonate, polyfluoroacrylates, amorphous fluorinated polymers; poly 2,2-bis (trifluoromethyl)-4,5 difluoro 1,3-dioxoline-cotetrafluoroethylene, or poly 2,2,4,5-tetrafluoro 1,3-dioxol-4,5-yl tetrafluoroethylene.

19. The method according to claim 1, wherein at least one of the diffusible additives increases the refractive index of organic polymers and is selected from the group consisting of: benzophenome, biphenyl, 3-phenyltoluene, diphenyl sulphide and 1,2,4,5-tetrabromobenzene.

20. The method according to Claim 1, wherein at least one of the diffusible additives increases the refractive index of perfluorinated polymers and is selected from the group consisting of: N-pentafluorophenyldichlomaleimide, octofluoronapthalene, and pentafluorophenyl sulfide.

21. The method according to claim 1, wherein at least one of the diffusible additives decreases the refractive index of organic polymers and is selected from the group consisting of: tributylphosphate, triethylphosphate, glycerol triacetate, methylperfluorooctanate, and perfluoro2,5,8-trimethyl-3,6,9-trioxadodecanoic acid methyl ester.

22. The method according to claim 1, wherein at least one of the diffusible additives decreases the refractive index of organic polymers and is selected from the group consisting of: perfluoropolyether, perfluorotrihexylamine, and perfluoropentadecane.

23. The method according to claim 1, wherein at least one of the diffusible additives decreases the refractive index of organic polymers and is selected from compounds with a methacrylate or acrylate functionality and a perfluorinated unit.

24. The method according to claim 1, wherein said plastic optical transmission medium has a glass transition temperature in excess of 90°C at all radii.

25. The method according to claim 1, wherein said plastic transmission medium is able to operate with stability at temperatures up to 85°C.

26. The method according to claim 1, wherein said plastic optical transmission medium is a graded index plastic optical fiber having a glass transition temperature at all radii greater than 85°C.

27. The method according to claim 1, wherein said plastic optical transmission medium is a graded index plastic optical fiber having a numerical aperture greater than 0.1.

28. The method according to claim 1, wherein said plastic optical transmission medium is a graded index plastic optical fiber comprising perfluorinated polymers and perfluorinated low molecular weight compounds.

29. The method according to claim 1, further comprising inducing cross-linking.

30. The method according to claim 29, wherein said cross-linking is accomplished by exposing the plastic optical transmission medium to ultra-violet radiation.

31. A plastic optical transmission medium, comprising;

a polymeric material comprising an additive which modifies the refractive index of the polymeric material, wherein the additive is selected from the class of methyl esters of perfluoro (poloxa) monocarboxylic acids.

32. The plastic optical transmission medium according to claim 31, wherein said additive is perfluoro 2,5,8-trimethyl-3,6,9-trioxadodecanoic acid, methyl ester (PTTME).

33. A plastic optical transmission medium, comprising:

a polymeric material comprising an additive which modifies the refractive index of the polymeric material, wherein the additive is selected from the class of methyl esters of perfluoro aliphatic monocarboxylic acids.

34. The plastic optical transmission medium according to claim 33, wherein said additive is methyl perfluorooctanate.

35. A method of modifying the refractive index of a plastic optical transmission medium, comprising:

preparing a polymeric material; and

adding an additive which modifies the refractive index of the polymeric material, wherein the additive is selected from the class of methyl esters of perfluoro (poloxa) monocarboxylic acids.

36. The method according to claim 35, wherein said additive is perfluoro 2,5,8-trimethyl-3,6,9-trioxadodecanoic acid, methyl ester (PTTME).

37. A method of modifying the refractive index of a plastic optical transmission medium, comprising:

preparing a polymeric material; and

adding an additive which modifies the refractive index of the polymeric material, wherein the additive is selected from the class of methyl esters of perfluoro aliphatic monocarboxylic acids.

38. The method according to claim 37, wherein said additive is methyl perfluorooctanate.